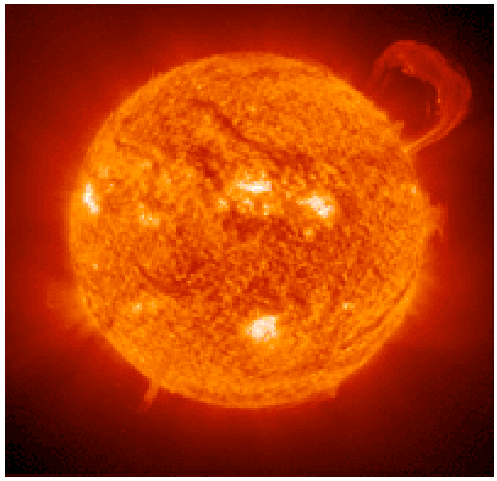
SOLAR WIND DATA ANALYSIS

Objectives:



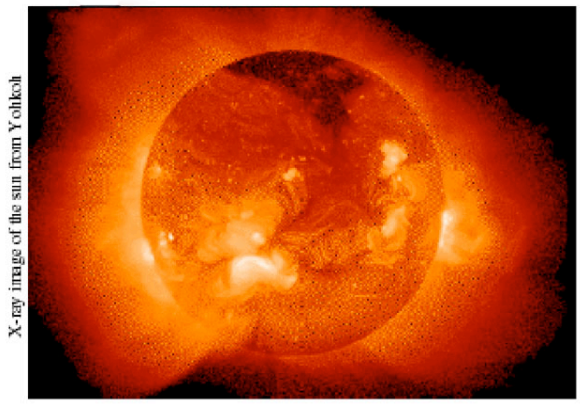
Students will learn how to understand and interpret solar wind data. Students will plot temperature and speed on semi-log graphing paper while working in cooperative groupings. The students/teacher will compile and compare results and discuss their findings.

Prerequisite Skills for Students

1. Students must have a basic understanding of the solar system; the Sun being the heart of the solar system with the planets revolving around it.
2. Students must have an understanding of solar dynamics.
3. Students must have a basic understanding of atomic structure (protons, electrons, and
4. nuclei).
5. Student must have basic graphing skills.
6. Student must have knowledge of Scientific notation.
7. Student must have a basic understanding of satellite uses.
8. Students must understand the concept of solar wind.
9. Student will need to be introduced to solar wind data sheets, and the symbols used to identify each measurement.

Background Information:

The Sun is the Heart of the Solar System



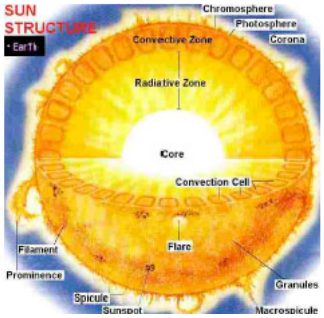
X-ray image of the sun from Yohkoh

The Sun is the heart of the solar system. The Sun is a dynamic, bright sphere, of mostly ionized gas. It is approximately 4.5 billion years old. It is the closest star to the earth.

The Sun supports life on earth by powering photosynthesis in green plants and is the source of all food. The Sun is the driver of earth's seasons, currents in the ocean, weather, and climate.

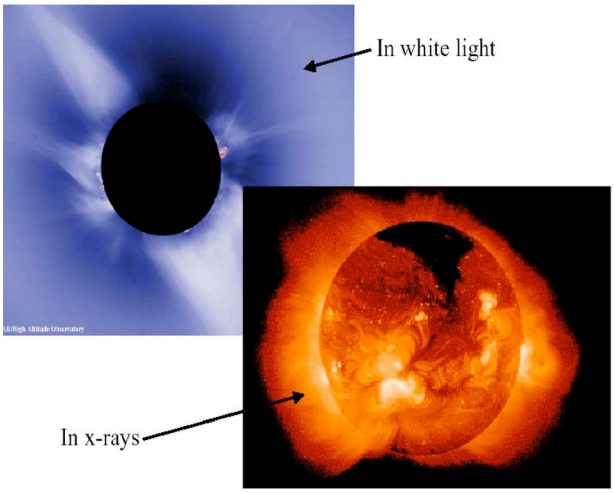
The temperature at the Sun's core is 16 million degrees Kelvin (K). This temperature is sufficient to sustain thermonuclear fusion reactions. The released energy prevents the collapse of the Sun and keeps it in gaseous form. The energy at the core of the Sun is equivalent to the energy generated by 100 billion tons of TNT exploding each second.

The interior of the Sun has two distinct regions. There are two zones known as a Radiative Zone and a Convective Zone. The temperature from the core decreases as it travels through these zones to the surface.



The surface of the Sun is known as the Photosphere. Above the Photosphere lies the Chromosphere. ("sphere of color") Above the Chromosphere lies the Corona ("crown"). This Corona extends outward from the Sun in the form of the "solar wind" to the edge of the solar system.

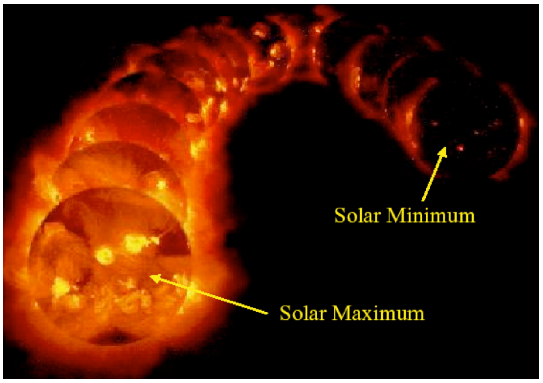
The Corona: Gateway to Interplanetary Space



Solar flares occur when magnetic energy that has built up in the solar atmosphere is suddenly released. During a flare, particles, including electrons, protons, and nuclei are heated, accelerate in the solar atmosphere, and large flares of x-rays are emitted. The amount of energy released is equal to millions of 100-megaton hydrogen bombs exploding at the same time. Another major dynamic event that occurs when magnetic energy is released is coronal mass ejections (CME's). Coronal mass ejections are huge bubbles of gas ejected from the corona over the course of several hours.

The following figure displays the solar variability during Solar Minimum and Solar Maximum. The brightest areas seen are known as Sunspots. Sunspots are dark regions of relatively cool material located within areas of strong magnetic fields known as active regions.

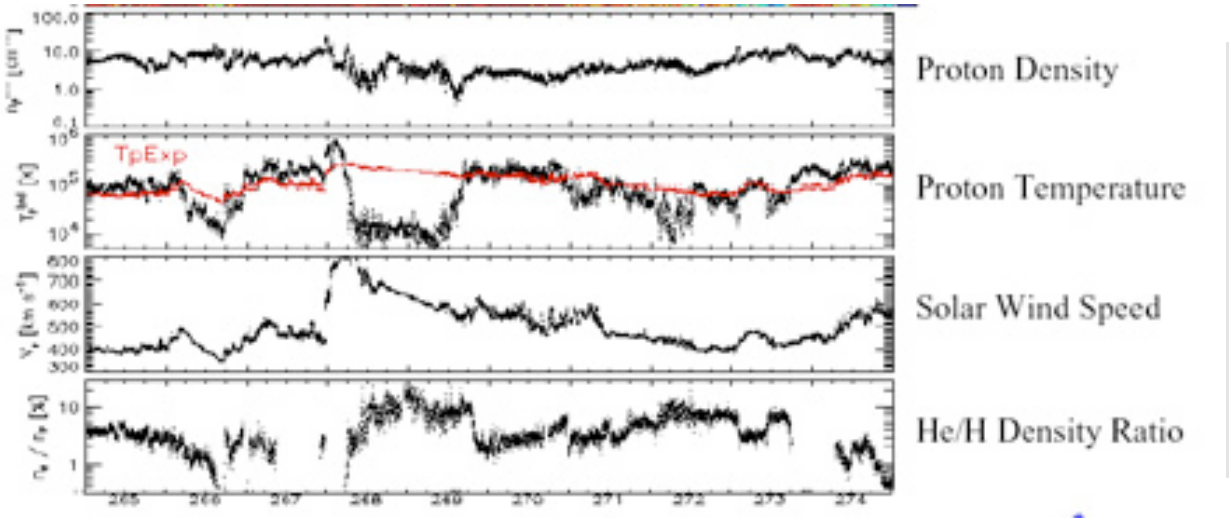
The number of Sunspots exhibits an 11-year cycle, known as the Sunspot cycle. There are two references for the cycle labeled solar minimum and solar maximum. Solar minimum will contain few Sunspots whereas the solar maximum is the most active range in the cycle containing several to many Sunspots. During solar maximum, the frequency of solar activity, like flares and CME's, increases; and there are correspondingly more disturbances in the solar wind.



Solar wind and solar storms are monitored by satellites and studied by Space Scientists because the wind causes effects on the earth's magnetic field. The "space weather" phenomena generally do not effect people on the Earth's surface, although they can occasionally cause power outages and damage to pipelines at high latitudes. They do produce hazards for spacecraft and they alter the communications properties of the Earth's atmosphere.

Solar wind is monitored and measured by various satellites (ACE, Genesis, and Ulysses). Instruments on these satellites collect data from which we derive the solar wind velocity, density, and temperature.

The following diagram displays actual data from the ACE satellite in 1998. The device sending the data to the scientists is called an electronic analyzer (or a plasma spectrometer) developed at the Los Alamos Laboratories. The measured solar wind properties are labeled at the right of the figure. (He = Helium, H = Hydrogen)



HELPFUL NOTES FOR THE TEACHER

(The following information is a short review for the students)

Atom: Smallest unit of matter that can be identified as a given *element*

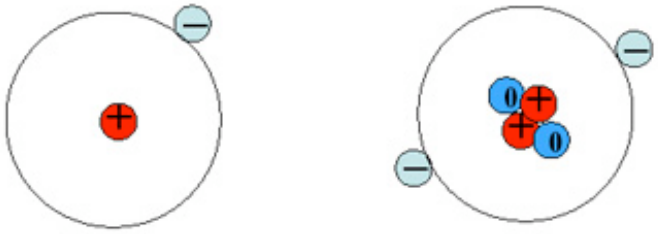
Nucleus includes:

positively charged particles – protons

electrically neutral particles – neutrons

Negatively charged particles – electrons – "orbit" the nucleus

Number of protons determines which element the atom is



Protons

positive electrical charge

mass = 1.67×10^{-27} kg

Neutrons

no electrical charge

mass = 1.67×10^{-27} kg (approx. same as proton)

Electrons

negative electrical charge

mass = 9.11×10^{-31} kg = proton mass / 1800